FAA-E-2820
August 19,1988

U.S. Department of Transportation
Federal Aviation Administration
Specification

MODEM, FIBER OPTICS, MULTIPLEXING, DROP-AND-INSERT

1. SCOPE AND CLASSIFICATION

1.1 Scope.- This specification contains the technical requirements of the Federal Aviation Administration (FAA) for a modular, general purpose, multiple channel, digital communications multiplexing modem with integrated fiber optic transmit and receive functions (hereinafter referred to simply as multiplexing modem). When three or more of the multiplexing modems specified herein are integrated, as in a network, the network shall have the capability to "drop-and-insert" digital communications channels at any one of up to eight locations. (The total number of channels shall not be required to exceed 32.) The multiplexing modem specified herein shall, in conjunction with a Network Monitoring System (NMS) provide the capability to remotely control and diagnose a network comprised of the same. Modules are specified which satisfy the interface and signal requirements of NAS-MD-790 and the land line/telephone line circuits of the four-wire modems of the airport surveillance radar model ASR-9, FAA specification FAA-E-2704B. These units are intended for use as the principal element in a fiber-optic-based signal distribution system for airports.

1.2 Classification.- The multiplexing modems shall be of two types as follows:

Type Ia- The optical components operate at an optical wavelength of 850 nanometers (nm) and are suitable for transmitting signals up to 2.5 km using cable specified by FAA-E-2761.

Type Ib- The same as Type Ia, but shall include a NMS.

Type IIa- The optical components operate at an optical wavelength of 1300 nm and are suitable for transmitting signals up to 15 km using cable specified by FAA-E-2761.

Type IIb- The same as Type IIa, but shall include a NMS.

1.3 Definition of terms

1.3.1 Modem.- The term modem, as used herein, shall denote a device which employs time division multiplexing/demultiplexing to effect the simultaneous transmission of data and control signals; and employs a signal transmission format such as Manchester-M, bi-phase encoding or pulse width modulation.

1.3.2 Data rate.- The term data rate, as used herein, shall denote bits per second non return to zero (NRZ).

1.3.3 Government inspection.- The term Government inspection, as used herein, shall denote the witnessing, by an FAA representative at the contractor's (or subcontractor's) facility, of any processes, tests, or inspections used to produce the specified equipment. Witnessing shall allow for any visual or other inspections necessary to assure compliance with this specification.

1.3.4 Isochronous distortion.- The term isochronous distortion, as used herein, shall denote the measurement of the deviation in pulse width (bias) and the deviation in bit cell boundary (jitter). Refer to EIA RS-334A, "Signal Quality At Interface Between Data Terminal Equipment and Synchronous Data Circuit Terminating Equipment for Serial Data Transmission" for specific measurement techniques.

1.3.5 dBm.- The term dBm, as used herein, shall denote decibels referenced to one milliwatt.

1.3.6 Reliability terms.- The reliability terms used in this specification are defined in the subparagraphs that comprise this section.

1.3.6.1 Failure.- The term failure, as used herein, shall denote any condition which requires corrective maintenance to restore the equipment function to specified operation.

1.3.6.2 Mean time between failure (MTBF).- The term MTBF, as used herein, shall denote the statistical mean measured in hours that the equipment operates according to specification between failures. Included in the definition of failure herein is a condition which requires adjustment in order to maintain and/or establish operation.

1.3.6.3 Mean time between critical failure (MTBCF).- The term MTBCF, as used herein, shall denote the statistical mean measured in hours between critical failures. A critical failure is differentiated from all other failures by its significant affect on the basic (critical) function(s) of the equipment. The

failure of a component associated with a critical function (critical failure) is in contrast to the failure of a component associated with supplementary functions such as providing for: visible status indication, internal monitoring/fault isolation, or redundant operation.

1.3.6.4 Mean time to restore (MTTR).- The term MTTR, as used herein, shall denote the statistical mean measured in hours and/or minutes to restore the system to full functional capability. The time measured is the total time required to diagnose to the module level, replace the defective module(s), and test.

1.3.6.5 Mean bench repair time (MBRT).- The term MBRT, as used herein, shall denote the statistical mean measured in hours and/or minutes to repair a modular component at a depot level facility. The time measured is the total time required to diagnose, repair, and test.

1.3.6.6 Critical improvement.- Critical improvements are hereby defined as improvements which relate to the ability of the equipment to satisfy the minimum specified requirements for mean time between failures.

1.3.7 Spacing.- The term spacing, as used herein, shall denote the logical state correlating to a "zero." By convention, this is normally associated with the busy or ON condition (for example, EIA-232, positive interchange voltage; EIA-422, circuit A is +200 millivolts to +6 volts with respect to circuit B).

1.3.8 Marking.- The term marking, as used herein, shall denote the logical state correlating to a "one." By convention, this is normally associated with the idle or OFF condition (for example, EIA-232, negative interchange voltage; EIA-422, circuit A is -200 millivolts to -6 volts with respect to circuit B).

1.3.9 Multidrop.- The term multidrop, as used herein, shall denote the capability of "dropping-and-inserting" signals using the same channel at every location.

1.3.10 DCE - Data Circuit-Terminating Equipment

1.3.11 DTE - Data Terminal Equipment

2. APPLICABLE DOCUMENTS

2.1 General.- The following documents, of the issue specified below, form part of this specification to the extent specified herein. In the event of a conflict between the requirements of this specification and documents listed or referenced herein, this specification shall have precedence.

(A limited number of copies of this specification and other applicable FAA documents may be obtained from the Contracting Officer in the FAA office issuing the IFB or RFP. Requests should fully identify the material desired (number, title, date of issue, etc.) and should identify the IFB or RFP or contract involved, or other use to be made of the material requested.)

(Information on obtaining FCC documents can be obtained from the FCC Offices 1114 21st Street NW, Washington,DC 20006.)

(EIA standards can be obtained from Electronic Industries Association, 2001 Eye Street NW, Washington, DC 20006.)

(Single copies of military specifications and standards can be obtained from the Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.)

2.2 FAA specifications and standards.-

FAA-D-2494/b	Technical Instruction Book Manuscript, Appendix I
FAA-G-2100e	Electronic Equipment, General Requirements
FAA-STD-020a	Transient Protection, Grounding, Bonding and Shielding Requirements for Equipment
NAS-MD-790	Remote Maintenance Monitoring System Interface Control Document Maintenance Processor Subsystem to Remote Monitoring Subsystems and Remote Monitoring Subsystem Concentrators
FAA-E-2704B	Airport Surveillance Radar
FAA-E-2761a	Cable, Fiber Optic, Multimode, Multifiber

2.3 Federal Communications Commission rules and regulations.-

Part 15, Radio Frequency Devices

2.4 Electronic Industries Association (EIA) standards.-

EIA-232D	Interface Between Data Terminal Equipment and Data Communications Equipment Employing Serial Binary Data Exchange
EIA-334A	Signal Quality at Interface Between Data Terminal Equipment and Synchronous Data Circuit Terminating Equipment for Serial Data Transmission
EIA-422A	Electrical Characteristics of Balanced Voltage Digital Interface
EIA-449	General Purpose 37-Position and 9-Position interface for Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange

2.5 Military specifications and standards.-

MIL-C-45662A	Military Specification, Calibration System Requirements

MIL-STD-721C Military Standard, Definition of Terms for Reliability and Maintainability

MIL-STD-454J Military Standard, Standard General Requirement for Electronic Equipment, Requirement 9

MIL-STD-882B Military Standard, System Safety Program Requirements

3. REQUIREMENTS

3.1 General.- The multiplexing modem described in this specification will be the principle element in an airport fiber optic-based signal distribution system. The multiplexing modem shall be of a modular design and consist of: an optical transceiver with multiplexing/demultiplexing logic, up to eight digital communication modules, built in test functions, and power supply.

3.1.1 Digital communications module types.- Digital communications modules of the following types shall be provided: (1) EIA-232, (2) EIA-422, (3) two-wire intra-network digitized voice, (4) transistor-transistor logic (TTL), and (5) four-wire intra-network digitized voice.

3.1.2 Digital communications channel.- A channel is herein specified as being one of the following:

(a) One full duplex EIA-232 port as specified in 3.2.2.4,

(b) One full duplex EIA-422 port as specified in 3.2.2.5,

(c) Four full duplex TTL ports as specified in 3.2.2.6.

(d) Two full duplex two-wire intra-network digitized voice frequency ports as specified in 3.2.2.7, or

(e) Two full-duplex four-wire intra-network digitized voice frequency ports as specified in 3.2.2.8.

3.1.3 Partitioning.- With the exception of the EIA-422 digital communication module, digital communications modules shall consist of four or a multiple of four digital communications channels. The EIA-422 digital communication module shall consist of one or more digital communication channels.

3.1.4 Networking.- It shall be possible to network, via optical fiber, as few as two and as many as eight multiplexing modems.

3.1.5 Network monitoring system.- A NMS shall be provided to remotely control and diagnose a network of multiplexing modems. The specifications for the NMS are defined in section 3.2.4.3.

3.1.6 Chassis capacity.- Each multiplexing modem chassis shall accommodate 8 or more digital communication modules.

3.1.7 System integration.- The multiplexing modem shall be effectively and virtually transparent. The multiplexing modem shall function in a manner which is in effect indistinguishable from point to point wiring.

3.2 Functional requirements

3.2.1 Modes of operation.- The multiplexing modems shall be capable of operating in either of two full duplex modes, point-to-point, or in a ring topology that provides the capability to "drop-and-insert" digital communications channels in multiples of four at any one of eight locations. In the ring topology it shall be possible to multidrop an EIA-232 and/or an EIA-422 signal by using Government furnished devices to retransmit the signal and to control the transmission of data being inserted into the ring.

3.2.2 Digital communications modules.- The digital communications modules shall have the following salient features. Each channel associated with a given type of digital communications module shall have the same interface characteristics. Connector interface panels to provide pin reassignments and/or connector transitions from commercially available units to the pin assignments and/or connectors specified in 3.2.2.4.2, 3.2.2.5, 3.2.2.6.3, 3.2.2.7.5 and 3.2.2.8.5 shall be allowed. If connector interface panels are needed to satisfy the requirements, the contractor shall provide the interface connector panel as specified by paragraph 3.4.1.2 and all necessary interconnecting cables.

3.2.2.1 Bit error rate (BER).- The BER attributable to the multiplexing modem shall not exceed 10^{-9} for received optical power levels within the range of -20 dBm to -32 dBm for 850 nm and the range of -17dBm to -37 dBm for 1300 nm. See 3.2.3.1 for transmitter specifications.

3.2.2.2 Data rate.- The EIA-232 and EIA-422 ports/channels shall be capable of operating at data rates from 0 to 19.2 Kbps (synchronous and asynchronous).

3.2.2.3 Isochronous distortion.- The cumulative isochronous distortion (attributable to the multiplexing modems) of either a EIA-232 or EIA-422 signal, which has been transmitted from any multiplexing modem in a system consisting of eight multiplexing modems configured topologically as a ring to any other multiplexing modem in the system, shall not exceed 20% for asynchronous and 5% for synchronous for received power levels within the specified range indicated in section 3.2.3.1.

3.2.2.4 EIA-232 module.- The electrical interface shall comply with EIA-232 unless specified otherwise herein.

3.2.2.4.1 Electrical signal slew rate.- The slew rate of the electrical signal produced by the multiplexing modem shall not be less than 10 volts/microsecond for a signal transition from -5 to +5 volts.

3.2.2.4.2 Interface connector.- The electrical interface connectors shall have the following contact assignments (see 3.2.2 and 3.2.5.2):

CONTACT	MNEMONIC/ EIA CIRCUIT		SIGNAL FLOW TO/FROM DCE	FUNCTION
1	FG			frame ground
2	TD	(BA)	to	transmitted data
3	RD	(BB)	from	received data
4	RTS	(CA)	to	request to send
5	CTS	(CB)	from	clear to send
6	DSR	(CC)	from	data set ready
7	SG	(AB)		signal ground
8	DCD	(CF)	from	data carrier detect
9				
10	TM	(*)	to	test mode
11				
12				
13				
14				
15	TC	(DB)	from	transmitter clock
16				
17	RC	(DD)	from	receiver clock
18				
19				
20	DTR	(CD)	to	data terminal ready
21				
22	RI	(CE)	from	ring indicator
23				
24	TC	(DA)	to	external transmitter clock
25				

(*) Not defined in EIA-232, test mode shall be activated by applying an enabling voltage to pin 10 from DTE or by way of a switch on the front panel of the multiplexing modem.

3.2.2.5 EIA-422 module.- The electrical interface shall comply with EIA-422/EIA-449 and be designated DCE.

(a) a capability shall be provided to fix request to send in the "ON" state

(b) clocks for receive data shall be provided

(c) the receive data output shall be in the continuously "marking" state when receiver ready is 'ON" and receive timing is active.

3.2.2.6 TTL module.-

3.2.2.6.1 Data rate.- The TTL module shall have the capability of transmitting/receiving 500 pulse per second signals on each of the four full duplex ports for each of the four channels associated with a TTL module.

3.2.2.6.2 Sampling skew.- The sampling skew shall not exceed ten microseconds between the signals associated with any two ports.

3.2.2.6.3 Connector contact assignments.- The connector shall have the following contact assignments (see 3.2.2 and 3.2.5.2):

CONTACT	ASSIGNMENT INPUT CHANNEL	PORT	CONTACT	ASSIGNMENT OUTPUT CHANNEL	PORT
1	1	1	20	1	1
2	1	2	21	1	2
3	1	3	22	1	3
4	1	4	23	1	4
5			24		
6	2	1	25	2	1
7	2	2	26	2	2
8	2	3	27	2	3
9	2	4	28	2	4
10	GROUND		29	3	1
11	3	1	30	3	2
12	3	2	31	3	3
13	3	3	32	3	4
14	3	4	33		
15			34	4	1
16	4	1	35	4	2
17	4	2	36	4	3
18	4	3	37	4	4
19	4	4			

3.2.2.7 Intra-network two-wire digitized voice frequency module.-

3.2.2.7.1 General.- Each two-wire intra-network digitized voice frequency port shall provide the capability to transmit and receive transformer coupled voice frequency tones full duplex, point-to-point, intra-network.

3.2.2.7.2 Impedance.- The input and output impedance shall be 600 ohms $\pm$ 5%.

3.2.2.7.3 Input/output signal levels.- Each port shall be capable of transmitting and receiving root-mean-square signal levels within the range of +1 dBm to -15dBm with a maximum inaccuracy of 0.5 dB for frequencies in the range of 300 Hz to 3400 Hz.

3.2.2.7.4 Pulse code modulation distortion. The end-to-end pulse code modulation distortion shall not exceed -35 dB (0 dBm at 1004 Hz).

3.2.2.7.5 Connector contact assignments.- The module connector(s) for the signals shall have the following contact assignments (see 3.2.2 and 3.2.5.2):

CONTACT	ASSIGNMENT	CONTACT	ASSIGNMENT
1	PORT1 (+)	14	PORT1 (-)
2	PORT2 (+)	15	PORT2 (-)
3	PORT3 (+)	16	PORT3 (-)
4	PORT4 (+)	17	PORT4 (-)
5		18	
6		19	
7	GROUND	20	
8	PORT5 (+)	21	PORT5 (-)
9	PORT6 (+)	21	PORT6 (-)
10	PORT7 (+)	23	PORT7 (-)
11	PORT8 (+)	24	PORT8 (-)
12		25	
13			

3.2.2.8 Intra-network four-wire voice frequency module.-

3.2.2.8.1 General.- Each four-wire intra-network digitized voice frequency port shall provide the capability to transmit and receive full-duplex, four-wire modem, point-to-point, intra-network communications.

3.2.2.8.2 Impedance.- The input and output impedance shall be 600 ohms ±5%.

3.2.2.8.3 Input/output signal levels.- Each port shall be capable of transmitting and receiving levels within the range of +1 dBm to -15 dBm with a maximum inaccuracy of 0.5 dB for frequencies in the range of 300 Hz to 3400 Hz.

3.2.2.8.4 Pulse code modulation distortion.- The end-to-end pulse code modulation distortion shall not exceed -35 dB (0 dBm at 1004 Hz).

3.2.2.8.5 Connector contact assignments.- The module connector(s) for the signals shall have the following contact assignments (see 3.2.2 and 3.2.5.2):

CONTACT	ASSIGNMENT	CONTACT	ASSIGNMENT
1	PORT1 (+) TRANSMIT	20	PORT1 (-) TRANSMIT
2	PORT1 (+) RECEIVE	21	PORT1 (-) RECEIVE
3	PORT2 (+) TRANSMIT	22	PORT2 (-) TRANSMIT
4	PORT2 (+) RECEIVE	23	PORT2 (-) RECEIVE
5	PORT3 (+) TRANSMIT	24	PORT3 (-) TRANSMIT
6	PORT3 (+) RECEIVE	25	PORT3 (-) RECEIVE
7	GROUND	26	
8		27	
9		28	
10		29	
11	PORT5 (+) TRANSMIT	30	PORT5 (-) TRANSMIT
12	PORT5 (+) RECEIVE	31	PORT5 (-) RECEIVE

CONTACT	ASSIGNMENT	CONTACT	ASSIGNMENT
13	PORT6 (+) TRANSMIT	32	PORT6 (-) TRANSMIT
14	PORT6 (+) RECEIVE	33	PORT6 (-) RECEIVE
15	PORT7 (+) TRANSMIT	34	PORT7 (-) TRANSMIT
16	PORT7 (+) RECEIVE	35	PORT7 (-) RECEIVE
17	PORT8 (+) TRANSMIT	36	PORT8 (-) TRANSMIT
18	PORT8 (+) RECEIVE	37	PORT8 (-) RECEIVE
19	GROUND		

3.2.2.9 Digital communications modules - summary. Table I summarizes the partitioning of the modules specified in paragraphs 3.2.2.4 through 3.2.2.8.

Table I

MODULE TYPE	Number of Full-Duplex PORTS per CHANNEL	Minimum Number of CHANNELS per MODULE	Number of PORTS per CONNECTOR	MINIMUM Number of CONNECTORS per MODULE
EIA-232	1	4	1	4
EIA-422	1	1	1	1
TTL	4	4	16	1
TWO-WIRE INTRA-NETWORK DIGITIZED VOICE	2	4	8	1
FOUR-WIRE INTRA-NETWORK DIGITIZED VOICE	2	4	8	1

3.2.3 Optical transceiver module.- The optical transceiver shall incorporate a redundant fiber optic transmitter and receiver which shall, within 100 milliseconds of a failure in the primary devices, assume the function thereof and enable a corresponding bit in the local fault detection/isolation logic.

3.2.3.1 Transmitter.- The transmitter shall be light emitting diode (LED) based. The drive current shall not exceed the maximum recommended for the LED by the LED manufacturer. The transmitter output shall have the following characteristics.

3.2.3.1.1 Type I.- Type I transmitter output shall meet the following specifications:

(a) Wavelength: 850 nm +/-30 nm

(b) Spectral width: 50 nm full width half maximum (FWHM)

(c) Power: -20 dBm +3/-0 dB coupled into 50/125 micron, 0.22 NA fiber

3.2.3.1.2 Type II.- Type II transmitter output shall meet the following specifications:

(a) Wavelength: 1300 nm +/- 50 nm

(b) Spectral width: 100 nm,FWHM

(c) Power: -17 dBm +3/-0 dB coupled into 50/125 micron, 0.22 NA fiber

3.2.3.2 Receiver.- The detector of the receivers shall use positive-intrinsic-negative (PIN) diodes.

3.2.3.2.1 Dynamic range.- The full performance dynamic range shall not be less than 12 dB for 850 nm and shall not be less than 20 dB for 1300 nm.

3.2.3.2.2 Threshold.- When the received optical power is not sufficient to sustain a 10^{-6} BER, the receiver shall cause the electrical outputs of the EIA-232 and EIA-422 digital communications ports to produce a continuous marking state and shall generate a transceiver fault indication.

3.2.3.2.3 Response.- The receiver shall not produce a state wherein the electrical interface of the EIA-232 and EIA-422 digital communications ports and the optical receiver can assume a spacing condition except in response to an optical signal which meets or exceeds the threshold for a spacing condition. Neither shall the design of the digital communications module allow the electrical output of the EIA-232 and EIA-422 digital communications ports to assume a spacing condition except in direct response to a corresponding optical signal during the assigned time interval for the respective port.

3.2.3.3 Multiplexer/demultiplexer logic.- The function of the transceiver, in addition to that of the optical transmitter and receiver, shall include the following:

- o timing
- o time division multiplexing of the signals of the digital communications modules to produce a composite interleaved bit (or eight bit byte) digital signal.
- o formatting/encoding the digital carrier to be autosynchronous.
- o decoding and demultiplexing the digital carrier signal.

The functionality specified herein may be logically partitioned so as to define a module separate from and in addition to the transceiver module.

3.2.4 Testing and fault diagnosis

3.2.4.1 Local fault isolation.- The multiplexing modem, independent of any device external to the chassis, shall provide the capability to identify channel related faults by channel, power supply faults, and transceiver faults.

3.2.4.2 Indicators and alarms.- The following indicators and/or alarms shall be provided on the front panel of the multiplexing modem:

(a) Power supply indicators

(b) Optical signal detect/received power sufficient to sustain a BER of 10^{-6} or less

(c) Digital loopback test fault

(d) Switch-selected channel status for all active pins

3.2.4.3 Network monitoring system (NMS).- The NMS specified herein is specified in the context of its proposed use within the Remote Maintenance Monitoring System (RMMS).

3.2.4.3.1 NMS functional requirements.- The NMS shall have the capability to communicate with the testing and fault isolation logic of the multiplexing modems within the network in order to monitor EIA-232 and EIA-422 digital communications within a network of up to eight multiplexing modems without interferring with or interrupting the transmission of data. Use of one of the operational EIA-232 digital communications ports per remote multiplexing modem is allowed for this purpose.

3.2.4.3.2 NMS self-diagnostics.- The NMS shall incorporate internal test/validation and diagnostic features. NMS status shall be provided to the RMMS when requested.

3.2.4.3.3 Fail safe design.- The NMS shall incorporate features which minimize the probability that a failure internal to the NMS will cause a failure with systemic impact.

3.2.4.3.4 Data rate.- The NMS shall be capable of communicating with the RMMS at a data rate of 2400 bits per second synchronous.

3.2.4.3.5 NMS/RMMS transactions.- As a minimum, the NMS shall have included in its repetoire of transactions with the RMMS messages of the following types:

- Messages containing requested information
- Messages, for example, confirming that a request for status or testing was received
- Messages confirming that a request was honored
- Message indicating that an invalid request was received.

More specifically, the NMS shall be capable of acknowledging and responding to RMMS requests for:

- o NMS status - as frequently as once every 10 seconds
- o Data upon demand
  - Fault status of multiplexing modem network
  - Configuration of the multiplexing modem network
  - Operational status of multiplexing modem network
- o Fault isolation testing
  - Local and remote loop-back testing of digital communication ports
  - Diagnostics

3.2.4.3.6 NMS Protocol and procedures.- The protocol and procedures for all transactions between the NMS and the RMMS shall be as defined in NAS MD-790.

3.2.4.3.7 NMS Visual status indicators.- As a minimum, the NMS display screen shall provide the following status information:

(a) Carrier detect - to indicate that an optical signal sufficient to sustain a BER of less than 10^{-6} has been received.

(b) Error indicators (local/remote)-reference paragraph 3.2.4.2c

(c) Status indicators (local/remote)-reference paragraphs 3.2.4.2a and 3.2.4.2d

(d) Test mode - to indicate that test mode is enabled.

3.2.4.3.8 NMS operator interface panel.- The NMS operator interface panel shall provide, as a minimum:

(a) The ability using a password to select local or RMMS control as well as a key switch to lock-out remote control

(b) Ability to initiate and terminate tests

3.2.4.3.9 NMS functional testing/diagnosis.- The NMS shall provide the capability for on-line or off-line functional testing/diagnosis and fault isolation of a network. It shall be possible to order such either directly from the NMS operator interface panel or indirectly from the RMMS via the NMS.

3.2.5 Connectors

3.2.5.1 Optical.- The optical connectors shall be Amphenol 906 or equivalent.

3.2.5.2 Digital communications electrical interface.- The electrical interface connectors shall be Amphenol series 117 with receptacle contacts or equivalent. The EIA-232 and the two-wire digitized intra-network voice frequency channel connectors shall be the DB shell type. The EIA-449, the four-wire digitized intra-network voice frequency, and the TTL channel connectors shall be DC shell type.

3.2.6 Power supply module.- The power supply module shall provide a redundant power supply which shall, in the event of a failure in the primary power supply, instantaneously assume the full operational load of the multiplexing modem and enable a corresponding bit in the local fault detection/isolation logic.

3.3 Power.- The equipment shall operate using 117 volt AC, 60 Hz, single-phase input power. The equipment shall operate continuously and unattended while power is applied.

3.3.1 Power consumption.- The power required for a chassis configured for 8 digital communication modules and a network monitoring system shall not exceed 250 watts.

3.3.2 Conditions of varying input power.- All specification requirements shall be satisfied when the equipment is operated under all fixed or varying combinations of AC line voltage and frequency within the ranges specified below. Requirements shall also be satisfied when such input power variations are combined with variations of service conditions, as described in 3.5.

(a) Line voltage: 105 to 135 AC

(b) Line frequency: 57 to 63

3.3.3 Transient protection.- The equipment shall be provided with transient protection to satisfy the requirements of FAA-STD-020, 3.5, 3.5.1, 3.5.3, and 3.6.

3.4 Physical characteristics

3.4.1 Size.-

3.4.1.1 Multiplexing modem.- The overall physical dimensions of the equipment which includes a separate chassis for the network monitoring system and a chassis capable of accommodating 8 digitial communication modules, the primary power supply, the standby power supply, and the optical transceiver shall be as specified below. The dimensional tolerances are hereby defined as $\pm$0.015 inches.

(a) Height: The height including tolerance shall not exceed 21.015 inches

(b) Depth: The depth including tolerance shall not exceed 17.515 inches

(c) Width: The chassis shall be 19 inch rack mountable

3.4.1.2 Connector interface panel.- Connector interface panels which shall be either directly mountable on the multiplexing modem chassis, or 19 inch rack mountable shall not exceed 5.40 inches in height including a +/-0.015 inch tolerance.

3.4.2 Weight.- The total operational weight of a system configured with 8 Digital Communications Modules and a NMS shall not exceed 50 pounds.

3.5 Environmental conditions.- The equipment shall satisfy the requirements for operation and storage under varying environmental conditions.

3.5.1 Operating temperature, humidity and altitude.-

3.5.1.1 Multiplexing modem.- The multiplexing modem shall satisfy requirements when operated under fixed or varying conditions of temperature, humidity and altitude for the ranges specified.

(a) Temperature: -50° C to 50° C (The multiplexing modem shall not require, nor shall it employ, a thermoelectric device when operating within the temperature range of -20° C to +50° C. If thermoelectric device(s) is (are) required for operation below temperatures of -20° C, the following additional requirements shall be imposed:

- o Power requirement for the thermoelectric device(s) shall not exceed 25 watts.
- o The MTBF (MTBCF) for the thermoelectric device(s) shall not be less than 200,000 hours.
- o The time required to replace the thermoelectric device(s) shall not exceed two hours.
- o The failure of the thermoelectric device(s) shall be reported to and identified by the NMS as a system failure.)

(b) Humidity: 10 to 90% RH

(c) Altitude: to 10,000 feet

3.5.1.2 NMS.- The NMS, including display screen, operator terminal, and processor shall satisfy requirements when operated under fixed or varying conditions of temperature, humidity, and altitude for the ranges specified:

(a) Temperature: 10 to +50°C
(b) Humidity: 10-90% RH, noncondensing
(c) altitude: to 10,000 feet

3.5.2 Storage temperature, humidity and altitude.-

(a) Temperature: -50° C to 60° C

(b) Humidity: 10 to 95% RH, noncondensing

(c) Altitude : to 40,000 feet

3.5.3 Shock and vibration

3.5.3.1 Shock.- The equipment shall be capable of withstanding shock impulses in any orientation without subsequent malfunction as follows.

(a) Operational: 5g, 11 millisecond half-sinewave

(b) Non-operational: 10g, 11 millisecond half-sinewave

3.5.3.2 Vibration.- The equipment shall be capable of normal operation during and after two cycles of testing in each of three orthogonal axes as follows:

Displacement or Acceleration	Frequency (Hz)
0.20 inch	5 to 10
1 g	10 to 200

The test cycle is defined as a logarithmic sweep from 5 to 200 Hz and having a sweep duration of 30 minutes.

3.5.4 EMI susceptibility.- The equipment shall not be susceptibile to: (1) an E-field emission equal to 10 volts per meter over the frequency range of 14 kHz to 30 MHz; (2) an E-field emission of 5 volts per meter above 30 MHz; or (3) a magnetic flux density of 148 dB above one picotesla at 60 Hz.

3.6 Workmanship, materials and finishes

3.6.1 Workmanship.- Workmanship shall be in accordance with MIL-STD-454, Requirement 9, paragraphs 2,3,4,5,6,9 and 10.

3.6.2 Materials and parts.- The specifications of all materials and parts shall have been derated to ensure that the equipment will operate as intended over the full range of environmental and input power conditions. The multiplexing modem shall be either fabricated from fungus-inert materials or conformally coated to provide an effective fungus resistant barrier.

3.6.3 Finishes.- All metal surfaces on cabinetry, panels, and structural parts shall be either painted, plated, or anodized to provide environmental protection.

3.6.4 Marking.- All marking shall be by silk screen or engrave-and-fill methods.

3.7 Reliability/maintainability

3.7.1 Figures of merit.- The equipment shall satisfy the following reliability and maintainability requirements:

(a) The MTBCF of an operational configuration exclusive of digital communications modules shall not be less than 50,000 hours.

(b) The MTBF for a multiplexing modem, including built in test equipment, operationally configured to include eight digital communications modules shall not be less than 10,000 hours. The MTBF of the NMS shall not be less than 10,000 hours.

(c) The MTTR shall not exceed 15 minutes.

(d) The MBRT shall not exceed 4 hours.

(e) Preventative maintenance shall not be required.

(f) The equipment shall be maintainable using standard commercially available equipment.

3.7.2 Reliability improvement program.- The contractor shall have established a progressive reliability improvement program. The program shall be evidenced by a reliability data base derived from failure analysis reports and product quality control and testing records. The program shall include a process whereby reliability improvements are identified as a result of periodic reviews of the reliability data base. The process shall consist of, as a minimum, evaluating possible critical improvements and identifying corresponding options for exchange or remedial modification of units in the field. Definitions and terms as they relate to reliability prediction shall be per MIL-STD-721.

3.7.3 Maintainability program.- The goal of a maintainability program is the enhancement of operational availability through the reduction of the time and resources required to perform restorative maintenance. The contractor shall have established a maintainability program which is, at least in part, evidenced by the following features in the equipment design:

(a) Fault detection indicators and/or alarms

(b) Built in test equipment for fault diagnosis

(c) Modular components, the designs of which are based on the logical partitioning of functions, and

(d) A line replaceable unit repair philosophy

The program shall include, as a minimum, a maintainability engineering review which is an integral part of the process for all design changes prompted by the reliability improvement program; and an established data base which is derived from factory repair-facility and field engineering problem resolution reports. Such reports shall be required for all maintenance actions provided by or supported by the contractor. Periodic review of the data base shall be scheduled to identify feasible product improvements.

3.8 Other requirements

3.8.1 Documentation.- As a minimum, the contractor shall deliver with each chassis, two copies of an instruction manual which complies with the requirements specified in FAA-D-2494, Appendix I.

3.8.2 Configuration management.- A configuration management plan shall be provided by the contractor for approval by the Contracting Officer. If the contractor incorporates revisions or modifications to any modules circuit boards or subassemblies, and these units are to appear in future production runs deliverable to the FAA, or as spare parts or replacement items, the contractor shall provide to the Contracting Officer documentation for such changes prior to delivery and a statement explaining why the change is necessary. Changes which affect the operation, installation, servicing, interchangeability, or functional characteristics of the equipment must have prior approval of the Contracting Officer.

3.8.3 Personnel safety.- Provisions for personnel safety shall be in accordance with FAA-G-2100, 3.3.7. The contractor shall have a system safety program in accordance with MIL-STD-882 Task 100 and Task 105.

3.8.4 EMI Control.- Conducted and radiated electromagnetic interference produced by the equipment shall be limited by FCC Rules and Regulations, Part 15.

3.8.5 Maintenance and repair.- The contractor shall list all measurement capability required to test the equipment.

4. QUALITY ASSURANCE PROVISIONS

4.1 Quality control program .- The contractor shall provide and maintain a quality control program in accordance with the contract. All tests and inspections made under this program shall be subject to review by the Government.

4.2 Tests

4.2.1 Test procedures.- The contractor shall submit to the Government for approval type test and production test procedures which will demonstrate the compliance of equipment performance with the specifications. The test procedures shall address each paragraph and/or subparagraph of the specification that is indicated in Table I as requiring acceptance tests and evaluation. Production acceptance tests and evaluation shall consist of one or more of the following: production tests, type tests, analysis, demonstration, and inspection.

4.2.1.1 Production tests and inspections.- Production tests, subject to normal service conditions, and inspections shall be performed on 100% of the total of each line item deliverable unless specified otherwise in Table I.

4.2.1.2 Type tests.- Type tests shall be performed over the range of specified service conditions per FAA-G-2100 section 4.3.3 and paragraph 4.11. Except for Group I, a minimum of one unit and a maximum of 5% of the units within a group shall be selected by the Government representative for testing. Only one type test shall be performed per group. The Government representative shall select the specific test to be performed and the number of units, if the Government representative determines that less than the maximum is required.

4.2.1.3 Demonstration and analysis.- Demonstrations and analyses that are required per Table I to establish compliance with specifications shall be conducted on the basis of one demonstration (analysis) per each line item deliverable.

4.2.2 Test results.- The contractor shall submit test results (which shall include analysis, if so specified by the Contracting Officer, for those paragraphs and/or subparagraphs listed in Table I as requiring analysis) to the Government for review and approval prior to final acceptance.

4.2.3 Test equipment.- The contractor shall supply all test equipment necessary for tests required in this specification. Test equipment shall be maintained in accordance with MIL-C-45662.

4.3 Inspection of production status.- Upon request from the Government, the contractor shall make available for review at the production facility, all information regarding the production status of equipment being manufactured under the contract.

5. PREPARATION FOR DELIVERY

5.1 General requirements.- Equipment, accessories and required documentation shall be packaged for shipment in a manner that prevents damage when shipped by common carrier. As a minimum, equipment packaged for shipment shall not be adversely affected by a free-fall impact on concrete from a height of 36 inches. Unpacking instructions, when required, shall be affixed to the exterior of the shipping container in a protective envelope, and shall be clearly labeled.

5.2 Marking.- The shipping container shall be clearly marked with permanent ink to provide the following information:

(a) Name, type, model number and quantity of equipment

(b) Name and address of manufacturer

(c) FAA contract number under which equipment is being supplied

(d) National stock number

6. NOTES.- The contents of this section are not contractually binding. Any information contained herein is for the purpose of providing background information and/or special instructions to the Contracting Officer.

6.1 Quality control provisions.- When the procurement request is prepared, an appropriate quality assurance provision must be included in the contract.

6.2 Testing.- The contractor may at the discretion of the Contracting Officer submit for approval by the Contracting Officer certified test results and/or product qualification records to demonstrate compliance with the requirements for testing defined in paragraph 4.2.1.2. The contractor shall, however, indicate at the time of submission the savings accrued to the Government as a result of exercising this option.

6.3 Reliability.- The contractor shall, at the time of submission of bids, substantiate that the equipment will satisfy the requirements for MTBCF and MTBF specified in 3.7.1 (a) and (b). The contractor shall provide reliability testing results and/or information derived from the contractor's reliability data base.

TABLE II. VERIFICATION REQUIREMENTS TRACEABILITY MATRIX FOR FACTORY ACCEPTANCE TESTING OF EQUIPMENT SPECIFIED BY FAA-E-2820

PARAGRAPH NUMBER	PARAGRAPH TITLE	TEST LEVEL UNIT	SUBSYSTEM	SYSTEM	REMARKS
3.	REQUIREMENTS	-	-	-	Title
3.1	General	-	-	-	Description
3.1.1	Digital communications module types	I	-	-	-
3.1.2	Digital communications channel	L	-	-	-
3.1.3	Partitioning	I	-	-	-
3.1.4	Networking	-	-	D	-
3.1.5	Network monitoring system	-	-	D	-
3.1.6	Chassis capacity	I	-	-	-
3.1.7	System integration	-	-	D	-
3.2	Functional requirements	-	-	-	Title
3.2.1	Modes of operation	-	-	D	-
3.2.2	Digital communications modules	I	I	-	-
3.2.2.1	Bit error rate (BER)	-	T	T	-
3.2.2.2	Data rate	-	T	-	SS
3.2.2.3	Isochronous distortion	-	D,A	D,A	-
3.2.2.4	EIA-232	D,A	-	-	-
3.2.2.4.1	Electrical signal slew rate	D,A	-	-	-
3.2.2.4.2	Interface connector	I	-	-	-
3.2.2.5	EIA-422	D,A	-	-	-
(a)					
(b)					
(c)					
3.2.2.6	TTL	-	-	-	Title
3.2.2.6.1	Data rate	-	D	D	-
3.2.2.6.2	Sampling skew	-	D	D	-
3.2.2.6.3	Connector contact assignments	I	-	-	-
3.2.2.7	Intra-network two-wire digitized voice frequency module		-	-	Title
3.2.2.7.1	General	-	D	D	-
3.2.2.7.2	Impedance	D	-	-	-
3.2.2.7.3	Input/output signal levels	T	-	-	-

Legend:

- = Not applicable, SS = Select Sample as in FAA-G-2100 Paragraph 4.3.3.1.1, TT = Type Testing, CPQ = Certified Product Qualification Data Issued by the Manufacturer of the LED will Satisfy Requirements, T = Test, D = Demonstration, A = Analysis, I = Inspection, L = Verified by Lower Level Requirement.

TABLE II. VERIFICATION REQUIREMENTS TRACEABILITY MATRIX FOR FACTORY ACCEPTANCE TESTING OF EQUIPMENT SPECIFIED BY FAA-E-2820

PARAGRAPH NUMBER	PARAGRAPH TITLE	TEST LEVEL UNIT	SUBSYSTEM	SYSTEM	REMARKS
3.2.2.7.4	Pulse code modulation distortion	-	D	-	-
3.2.2.7.5	Connector contact assignments	I	-	-	-
3.2.2.8	Intra-network four-wire digitized voice frequency module	-	-	-	Title
3.2.2.8.1	General	-	D	D	-
3.2.2.8.2	Impedance	D	-	-	-
3.2.2.8.3	Input/output signal levels	T	-	-	-
3.2.2.8.4	Pulse code modulation distortion	-	D	-	-
3.2.2.8.5	Connector contact assignments	I	-	-	-
3.2.2.9	Digital communications modules-summary	-	-	-	Title
3.2.3	Optical transceiver module	D	D	D	-
3.2.3.1	Transmitter	A	-	-	-
3.2.3.1.1	Type I	-	-	-	Title
(a)	Wavelength	T	-	-	CPQ
(b)	Spectral width	T	-	-	CPQ
(c)	Power	TT	-	-	SS
3.2.3.1.2	Type II	-	-	-	Title
(a)	Wavelength	T	-	-	CPQ
(b)	Spectral width	T	-	-	CPQ
(c)	Power	TT	-	-	SS
3.2.3.2	Receiver	I	-	-	-
3.2.3.2.1	Dynamic range	-	TT	TT	SS
3.2.3.2.2	Threshold	-	T	T	SS
3.2.3.2.3	Response	-	D,A	D,A	-
3.2.3.3	Multiplexing/demultiplexing logic	A	-	-	-
3.2.4	Testing and fault diagnosis	-	-	-	Title
3.2.4.1	Local fault isolation	D	D	-	-
3.2.4.2	Indicators and alarms	D	D	-	-
3.2.4.3	Network monitoring system (NMS)	D	D	D	-
3.2.4.3.1	NMS functional requirements	-	-	D	-
3.2.4.3.2	NMS self-diagnostics	-	D	-	-
3.2.4.3.3	Fail safe design	A	A	-	-

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PARAGRAPH NUMBER	PARAGRAPH TITLE	TEST LEVEL UNIT	SUBSYSTEM	SYSTEM	REMARKS
3.2.4.3.4	Data rate	-	-	T	-
3.2.4.3.5	NMS/RMMS transactions	-	-	D	-
3.2.4.3.6	NMS protocol and procedures	-	-	T	SS
3.2.4.3.7	NMS visual status indicators	-	-	T	-
3.2.4.3.8	NMS operator interface panel	-	-	D	-
3.2.4.3.9	NMS functional testing/ diagnosis	-	-	D	-
3.2.5	Connectors	-	-	-	Title
3.2.5.1	Optical	I	-	-	-
3.2.5.2	Digital communications electrical interface	I	-	-	-
3.2.6	Power supply module	D	D	D	-
3.3	Power	-	D	-	-
3.3.1	Power consumption	-	D	-	-
3.3.2	Conditions of varying input power	-	TT	-	-
3.3.3	Transient protection	-	A,TT	-	SS
3.4	Physical characteristics	-	-	-	Title
3.4.1	Size	-	-	-	Title
3.4.1.1	Multiplexing modem	I	-	-	-
3.4.1.2	Connector interface panel	I	-	-	-
3.4.2	Weight	-	I	-	-
3.5	Environmental conditions	-	-	-	Title
3.5.1	Operating temperature, humidity, and altitude	-	-	-	Title
3.5.1.1	Multiplexing modem	-	TT	-	SS
3.5.1.2	NMS	TT	-	-	SS
3.5.2	Storage temperature, humidity, and altitude	-	TT	-	SS
3.5.3	Shock and vibration	-	-	-	Title
3.5.3.1	Shock	-	-	-	Title
(a)	Operational	-	TT	-	SS
(b)	Non-operational	-	TT	-	SS
3.5.3.2	Vibration	-	TT	-	SS
3.5.4	EMI susceptibility	-	TT	-	SS
3.6	Workmanship, materials and finishes	-	-	-	Title

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PARAGRAPH NUMBER	PARAGRAPH TITLE	TEST LEVEL UNIT	SUBSYSTEM	SYSTEM	REMARKS
3.6.1	Workmanship	I	I	-	-
3.6.2	Materials and parts	-	A	-	-
3.6.3	Finishes	I	I	-	-
3.6.4	Marking	I	I	-	-
3.7	Reliability/maintainability	-	-	-	Title
3.7.1	Figures of merit				
(a)		A	-	-	-
(b)		A	A	-	-
(c)		-	D	-	-
(d)		-	A	-	-
(e)		-	A	-	-
(f)		D	D	D	-
3.7.2	Reliability improvement program	D	D	-	-
3.7.3	Maintainability program	D	D	-	-
3.8	Other requirements	-	-	-	Title
3.8.2	Configuration Management	D	D	-	-
3.8.3	Personnel safety	I	I	-	-
3.8.4	EMI control	-	TT	-	SS
3.8.5	Maintenance and repairs	D	D	D	-
5.0	PREPARATION FOR DELIVERY	-	-	-	Title
5.1	General requirements	T	T	-	SS
5.2	Marking	I	I	-	-

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